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(54) **Inner diameter variable vane actuation mechanism**

Betätigungsmechanismus der variablen Leitschaufeln am Innendurchmesser

Dispositif d'actionnement pour les aubes de guidage variables à diamètre interne

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Description

BACKGROUND OF THE INVENTION

[0001] This invention relates generally to gas turbine engines and more particularly to variable stator vane assemblies for use in such engines.

[0002] Gas turbine engines operate by combusting a fuel source in compressed air to create heated gases with increased pressure and density. The heated gases are ultimately forced through an exhaust nozzle, which is used to step up the velocity of the exiting gases and in-turn produce thrust for driving an aircraft. The heated air is also used to drive a turbine for rotating a fan to provide air to a compressor section of the gas turbine engine. Additionally, the heated gases are used for driving rotor blades inside the compressor section, which provides the compressed air used during combustion. The compressor section of a gas turbine engine typically comprises a series of rotor blade and stator vane stages. At each stage, rotating blades push air past the stationary vanes. Each rotor/stator stage increases the pressure and density of the air. Stators serve two purposes: they convert the kinetic energy of the air into pressure, and they redirect the trajectory of the air coming off the rotors for flow into the next compressor stage.

[0003] The speed range of an aircraft powered by a gas turbine engine is directly related to the level of air pressure generated in the compressor section. For different aircraft speeds, the velocity of the airflow through the gas turbine engine varies. Thus, the incidence of the air onto rotor blades of subsequent compressor stages differs at different aircraft speeds. One way of achieving more efficient performance of the gas turbine engine over the entire speed range, especially at high speed/high pressure ranges, is to use variable stator vanes which can optimize the incidence of the airflow onto subsequent compressor stage rotors.

[0004] Variable stator vanes are typically circumferentially arranged between an outer diameter fan case and an inner diameter vane shroud. A synchronizing mechanism simultaneously rotates the individual stator vanes in response to an external actuation source.

[0005] In some situations, it is advantageous to divide the compressor section into upper and lower halves to expedite maintenance of the gas turbine engine. It is particularly advantageous, for example, in military applications when maintenance must be performed in remote locations where complete disassembly is imprudent. However, in dividing the compressor section into halves, the synchronizing mechanism must also be split apart. This creates two synchronizing mechanisms that must be actuated in unison to orchestrate simultaneous operation of all of the stator vanes. Synchronizing mechanisms that are located on the outer case can be accessed and spliced together easily. However, this is not the case for inner diameter synchronizing mechanisms, which cannot be accessed after assembly to attach the synchronizing mechanisms together. Thus, there is a need for an apparatus for coordinating actuation of split inner diameter synchronizing mechanisms.

[0006] Prior art systems are shown in EP-0909880 and US-5259187.

BRIEF SUMMARY OF THE INVENTION

[0007] According to the present invention, there is provided a variable stator vane section as claimed in claim 1.

[0008] The present invention comprises a first drive vane arm and a second drive vane arm for driving a first variable vane array and a second variable vane array, respectively, of a stator vane section of a gas turbine engine. The first drive vane arm and second drive vane arm are connected to each other at a first end by a linkage. The first drive vane arm and second drive vane arm are connected at a second end to a first drive vane and a second drive vane, respectively, of the first and second variable vane arrays. The first drive vane arm and second drive vane arm respond in unison to a single actuation source connected to one of the first drive vane arm and second drive vane arm.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009]

FIG. 1A shows a back view of a stator vane section of a gas turbine engine in which the present invention is used.

FIG. 1B shows a side view of a stator vane section of a gas turbine engine in which the present invention is used.

FIG. 2 shows a close up perspective view of the actuation mechanism of the present invention shown in FIG. 1B.

FIG. 3 shows a top view of the actuation mechanism of the present invention.

DETAILED DESCRIPTION

[0010] FIG. 1A shows a back view of stator vane section 10 of a gas turbine engine in which the present invention is used. Stator vane section 10 comprises fan case 12, vane shroud 14, variable stator vane array 16 and actuator 18. Stator vane array 16 is comprised of drive vanes 20A and 20B and follower vanes 22A and 22B. Typically, follower vanes 22 encircle the entirety of vane shroud 14. For clarity, only a portion of variable stator vane array 16 is shown. Drive vanes 20 and follower vanes rotate about their axis in fan case 12 and inner diameter vane shroud 14. Drive vanes 20A and 20B are connected directly with actuator 18 at their outer diameter end. Drive vanes 20A and 20B are connected inside vane shroud 14 by a variable vane synchronizing mechanism such that when actuator 18 rotates drive vanes 20, follower vanes 22 rotate a like amount.

[0011] Stator vane section 10 is divided into first and second subassemblies. Fan case 12 is comprised of a first fan case component 24A and second fan case component 24B. Vane shroud 14 is similarly comprised of first vane shroud component 26A and second vane shroud component 26B. Stator vane array 16 is also comprised of a first array component 28A and second array component 28B component. In one embodiment, the fan case components, the vane shroud components and the vane array components comprise upper and lower assemblies for use in a split fan configuration. The first and second subassemblies come together at first split line 30A and second split line 30B. First array component 28A and second array component 28B operate independently from one another. The synchronizing mechanism contained within vane shroud 14 does not synchronize the rotation of the first array component 28A and second array component 28B because of the discontinuity caused by first split line 30A and second split line 30B.

[0012] FIG. 1B shows a side view of stator vane section 10 of a gas turbine engine in which the present invention is used. First fan case component 24A and second fan case component 24B come together at split line 30A. First fan case component 24A includes first array component 28A. Second fan case portion 24B includes second vane array 28B. First array component 28A and second array component 28B are independently synchronized with respective internal synchronizing mechanisms. Actuator 18 drives first array component 28A and second array component 28B with arm assembly 34. Arm assembly 34 includes linkage 36, which connects both first array component 28A and second array component 28B to actuator 18.

[0013] FIG. 2 shows a close up perspective view of arm assembly 34 shown in FIG. 1B. Arm assembly 34 comprises linkage 36, first arm 38A and second arm 38B. Linkage 36 can be disconnected from first arm 38A and or second arm 38B for uncoupling of first fan case 24A and second fan case 24B. First fan case portion 24A and second fan case portion 24B come together at seam line 30A.

[0014] First variable stator vane array 28A includes first stator vanes 22A that pivot within first fan case portion 24A at their outer diameter end. First stator vanes 22A are connected inside first vane shroud 24A by a synchronizing mechanism such that they all rotate in unison when any individual vane (e.g. drive vane 20A) is rotated. Second variable stator vane array 28B includes second stator vanes 22B that pivot within second fan case portion 24B at their outer diameter end. Second stator vanes 22B are connected inside second vane shroud 24B by a synchronizing mechanism such that they all rotate in unison when any individual vane (e.g. drive vane 20B) is rotated. First variable stator vane array 28A and second variable stator vane array 28B operate independently of each other.

[0015] Actuator 18 is connected to a drive mechanism (not shown) that causes up and down motion (as shown in FIG. 2) of actuator 18. Second variable stator vane array 28B is connected to actuator 18 with second arm 38B. As actuator 18 is moved up or down by the drive mechanism, drive vane 20B is rotated correspondingly. Preferably, drive vane 20B is selected to be next to or near split line 30A. Second arm 38B provides a moment arm for rotating stator vane 20B. As a result of drive vane 20B being rotated, second follower vanes 22B are also rotated by the synchronizing mechanism inside second vane shroud 26B.

[0016] First variable stator vane array 28A is connected to first arm 38A through drive vane 20A. First arm 38A is connected to second arm 38B by linkage 36. As second arm 38B is rotated by actuator 18, linkage 36 rotates first arm 38A. First arm 38A provides a moment arm for rotating drive vane 20A. Preferably, drive vane 20A is selected to be next to or near split line 30A. As a result of drive vane 20A being rotated, follower vanes 22A also rotated by the synchronizing mechanism inside second vane shroud 26A. Thus, a single actuator, actuator 18, drives both first variable stator vane array 28A and second variable stator vane array 28B.

[0017] FIG. 3 shows a top view of arm assembly 34 of the present invention. First arm 38A is connected to the outer diameter end of drive vane 20A. First arm 38A is approximately parallel to first fan case portion 24A and approximately in the same plane as second arm 38B. The specific size and location of first arm 38A and lower arm 38B are dictated by the location of other external components of the gas turbine engine, including the drive mechanism of actuator 18, and the specific actuation requirements of the particular variable vane arrays.

[0018] Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the scope of the claims.

Claims

1. A variable stator vane section (10) for use in a turbine engine, the stator vane section (10) comprising:

a first assembly comprising:

a first fan case (24A);
a first inner diameter vane shroud (26A);
a first drive vane (20A) rotatably positioned between the first fan case (24A) and the first inner diameter vane shroud (26A);
a first array of follower vanes (22A) rotatably positioned between the first fan case (24A) and the first inner diameter vane shroud (26A); and
a first drive vane arm (38A) for rotating the first drive vane (20A); and

a second assembly comprising:

a second fan case (24B);
a second inner diameter vane shroud (26B);
a second drive vane (20B) rotatably positioned between the second fan case (24B) and the second inner diameter vane shroud (26B);
a second array of follower vanes (22B) rotatably positioned between the second fan case (24B) and the second inner diameter vane shroud (26B); and
a second drive vane arm (38B) for rotating the second drive vane (20B);
an actuator (18); and
a linkage (36) for connecting the first drive vane arm (38A) and the second drive vane arm (38B) such that when one drive vane arm (38A, 38B) is rotated an amount by the actuator (18), the other drive vane arm (38, 38B) is rotated a like amount, thereby coordinating the rotation of both the first and second vane arrays.

2. The stator vane section (10) of claim 1, wherein the first drive vane arm (38A) and the second drive vane arm (38B) comprise:

a first end adapted for connection to a drive vane (20A,20B);
a second end adapted for connection to the linkage (36) and the actuator (18).

3. The stator vane section (10) of claim 1 or 2, wherein the first fan case (24A) and second fan case (24B) are joined at split lines (30A,30B).

4. The stator vane section (10) of claim 3, wherein the first drive vane (20A) is located next to a split line (30A) of the first fan case (24A).

5. The stator vane section (10) of claim 3 or 4, wherein the second drive vane (20B) is located next to a split line (30A) of the second fan case (24B).

6. The stator vane section (10) of any preceding claim wherein the linkage (36) is removable from the first drive vane arm (38A) and the second drive vane arm (38B).

Patentansprüche

1. Variabler Stator-Leitschaufelbereich (10) zur Verwendung in einer Turbinenmaschine, wobei der Stator-Leztschaufelbereich umfasst:

eine erste Anordnung (10) umfassend:

ein erstes Bläsergehäuse (24A);
eine Leitschaufelauskleidung (26A) mit einem ersten Innendurchmesser;
eine erste Antriebs-Leitschaufel (20A), die drehbar zwischen dem ersten Bläsergehäuse (24A) und der Leitschaufelauskleidung (26A) mit dem ersten Innendurchmesser angeordnet ist;
eine erste Anordnung von Folge-Leitschaufeln (22A), die drehbar zwischen dem ersten Bläsergehäuse (24A) und der Leitschaufelauskleidung (26A) mit erstem Innendurchmesser angeordnet sind; und
einen ersten Antriebs-Leitschaufelarm (38A) zum Drehen der ersten Antriebs-Leitschaufal (20A); und

eine zweite Anordnung umfassend:

ein zweites Bläsergehäuse (24B);
eine Leitschaufelauskleidung (26B) mit einem zweiten Innendurchmesser;
eine zweite Antriebs-Leitschaufel (20B), die drehbar zwischen dem zweiten Blasergehause (24B) und der Leitschaufelauskleidung (26B) mit zweitem Innendurchmesser angeordnet ist,
eine zweite Anordnung von Folge-Leitschaufeln (22B), die drehbar zwischen dem zweiten Bläsergehäuse (24B) und der Leitschaufelauskleidung (26B) mit zweitem Innendurchmesser angeordnet ist; und
einen zweiten Antriebs-Leitschaufelarm (38B) zum Drehen der zweiten Antriebs-Leitschaufel (20B);
einen Aktuator (18), und
eine Kopplung (36) zum Verbinden des ersten Antriebs-Leitschaufelarms (38A) und des zweiten Antriebs-Leitschaufelarms (38B), so dass, wenn ein Antriebs-Leitschaufelarm (38A, 38B) durch den Aktuator (18) um einen Betrag gedreht wird, der andere Antriebs-Leitschaufelarm (38, 38B) um einen gleichen Betrag gedreht wird, wodurch die Rotation sowohl der ersten als auch der zweiten Leitschaufelanordnung koordiniert wird.

2. Stator-Leitschaufelbereich (10) nach Anspruch 1, wobei der erste Antriebs-Leitschaufelarm (38A) und der zweite Antriebs-Leitschaufelarm (38B) umfassen:

ein erstes Ende, das zur Verbindung mit einer Antriebs-Leitschaufel (20A, 20B) ausgebildet ist;
ein zweites Ende, das zur Verbindung mit der Verbindung (36) und dem Aktuator (18) ausge-

bildet ist.

3. Stator-Leitschaufelbereich (10) nach Anspruch 1 oder 2, wobei das erste Bläsergehäuse (24A) und das zweite Bläsergehäuse (24B) an Trennlinien (30A, 30B) zusammengefügt sind.

4. Stator-Leitschaufelbereich (10) nach Anspruch 3, wobei die erste Antriebs-Leitschaufel (20A) neben einer Trennlinie (30A) der ersten Bläserummantelung (24A) angeordnet ist.

5. Stator-Leitschaufelbereich (10) nach Anspruch 3 oder 4, wobei die zweite Antriebs-Leitschaufel (20B) neben einer Trennlinie (30A) des zweiten Bläsergehäuses (24B) angeordnet ist.

6. Stator-Leitschaufelbereich (10) nach einem der vorangehenden Ansprüche, wobei die Kopplung (36) von dem ersten Leitschaufelantriebsarm (38A) und dem zweiten Leitschaufelantriebsarm (38B) entfernbar ist.

Revendications

1. Section d'aube de stator variable (10) pour l'utilisation dans un moteur à turbine à gaz, la section d'aube de stator (10) comprenant :

un premier ensemble comprenant :

un premier boîtier de soufflante (24A) ;
une première virole d'aube de diamètre intérieur (26A) ;
une première aube d'entraînement (20A) positionnée de manière rotative entre le premier boîtier de soufflante (24A) et la première virole d'aube de diamètre intérieur (26A) ;
un premier agencement d'aubes suiveuses (22A) positionné de manière rotative entre le premier boîtier de soufflante (24A) et la première virole d'aube de diamètre intérieur (26A) ; et
un premier bras d'aube d'entraînement (38A) pour faire tourner la première aube d'entraînement (20A) ; et

un deuxième ensemble comprenant :

un deuxième boîtier de soufflante (24B) ;
une deuxième virole d'aube de diamètre intérieur (26B) ;
une deuxième aube d'entraînement (20B) positionnée de manière rotative entre le deuxième boîtier de soufflante (24B) et la deuxième virole d'aube de diamètre intérieur (26B) ;
un deuxième agencement d'aubes suiveuses (22B) positionné de manière rotative entre le deuxième boîtier de soufflante (24B) et la deuxième virole d'aube de diamètre intérieur (26B) ; et
un deuxième bras d'aube d'entraînement (38B) pour faire tourner la deuxième aube d'entraînement (20B) ;
un actionneur (18) ; et
une liaison (36) pour connecter le premier bras d'aube d'entraînement (38A) et le deuxième bras d'aube d'entraînement (38B) de telle sorte que lorsqu'un bras d'aube d'entraînement (38A, 38B) est tourné d'une certaine distance par l'actionneur (18), l'autre bras d'aube d'entraînement (38, 38B) est tourné d'une distance égale, ce qui coordonne ainsi la rotation des premier et deuxième agencements d'aubes.

2. Section d'aube de stator (10) selon la revendication 1, dans laquelle le premier bras d'aube d'entraînement (38A) et le deuxième bras d'aube d'entraînement (38B) comprennent :

une première extrémité prévue pour être connectée à une aube d'entraînement (20A, 20B) ;
une deuxième extrémité prévue pour être connectée à la liaison (36) et à l'actionneur (18).

3. Section d'aube de stator (10) selon la revendication 1 ou 2, dans laquelle le premier boîtier de soufflante (24A) et le deuxième boîtier de soufflante (24B) sont réunis au niveau de lignes de séparation (30A, 30B).

4. Section d'aube de stator (10) selon la revendication 3, dans laquelle la première aube d'entraînement (20A) est située à côté d'une ligne de séparation (30A) du premier boîtier de soufflante (24A).

5. Section d'aube de stator (10) selon la revendication 3 ou 4, dans laquelle la deuxième aube d'entraînement (20B) est située à côté d'une ligne de séparation (30A) du deuxième boîtier de soufflante (24B).

6. Section d'aube de stator (10) selon l'une quelconque des revendications précédentes, dans laquelle la liaison (36) est détachable du premier bras d'aube d'entraînement (38A) et du deuxième bras d'aube d'entraînement (38B).

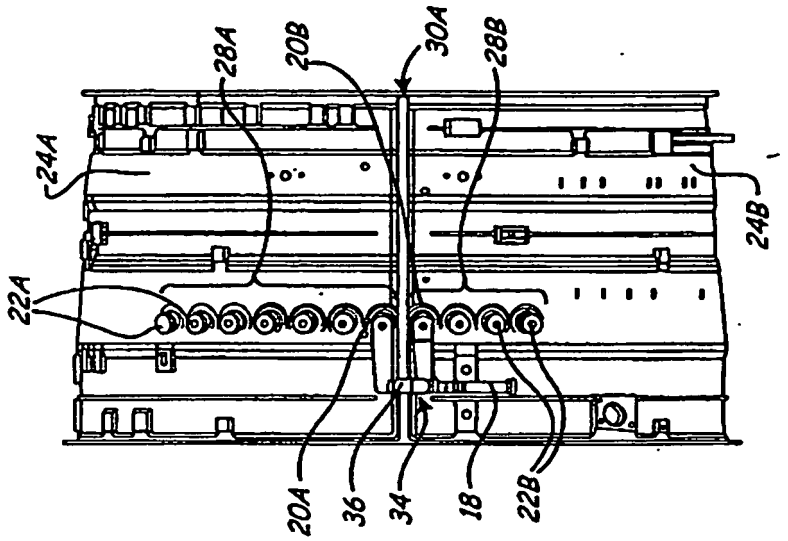

28A
20B
30A
28B
24A
24B
22A
20A
36
34
18
22B

Fig. 1B

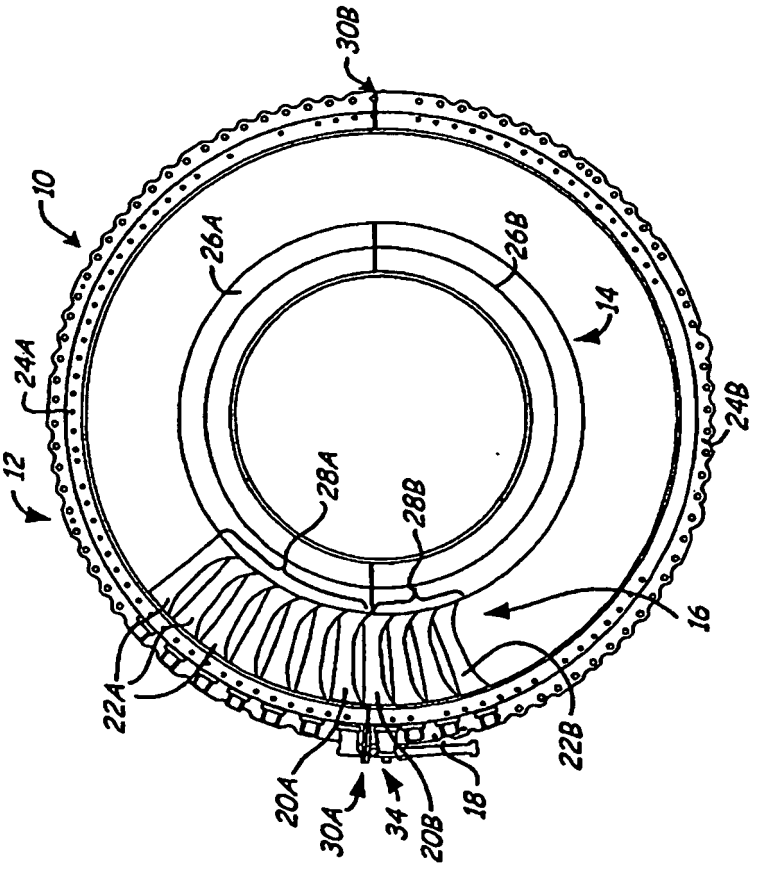

30B
10
26A
26B
14
24A
24B
12
28A
28B
16
22A
22B
20A
30A
34
20B
18

Fig. 1A

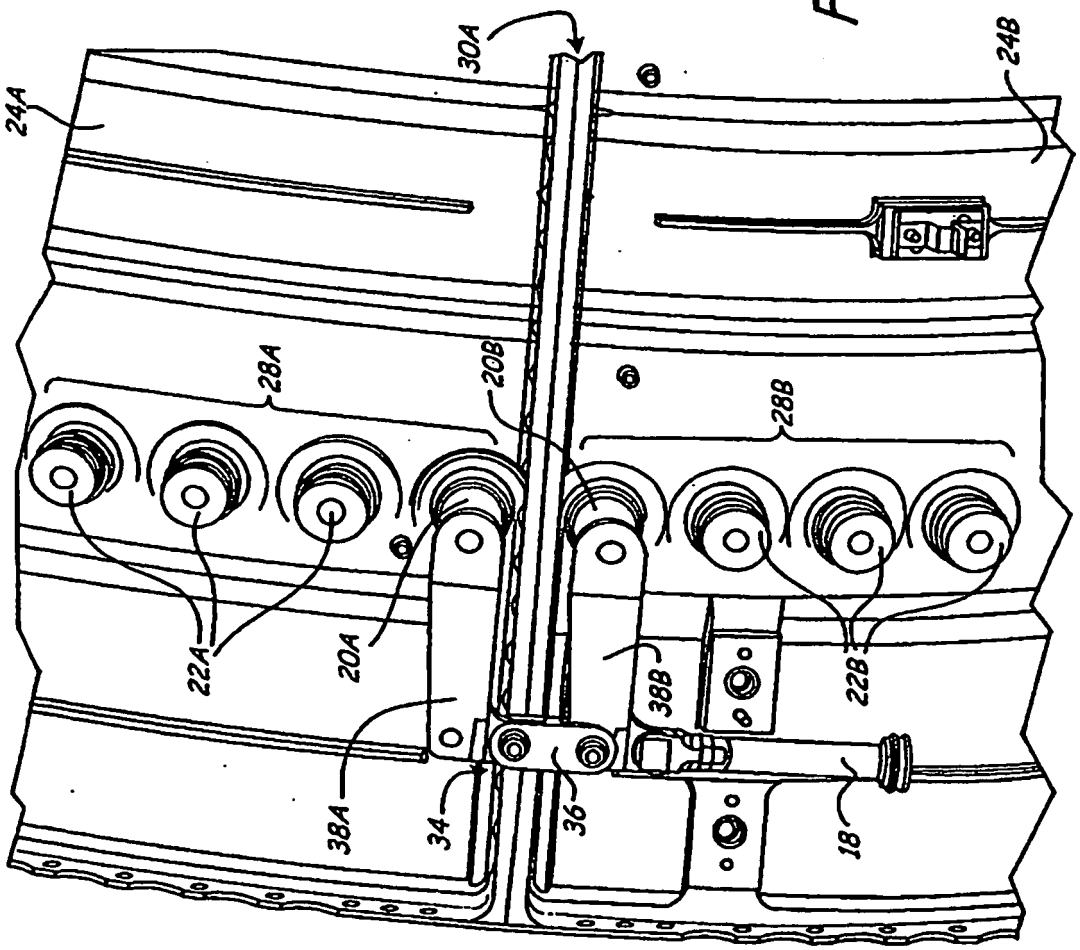


Fig. 2

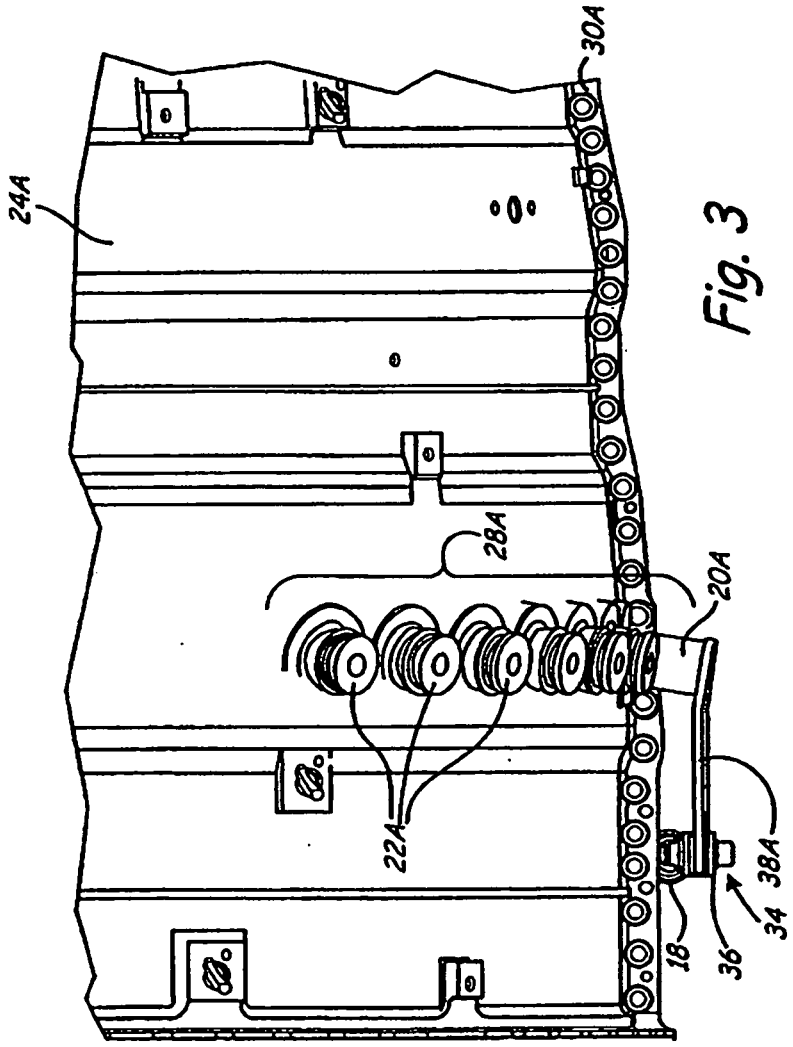


Fig. 3

REFERENCES CITED IN THE DESCRIPTION

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